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בקשה לפטנט
Application for Patent

אני, (שם המבקש, מענו – ולגבי גוף מאוגד – מקום התאגדותו)
I (Name and address of applicant, and, in case of a body corporate, place of incorporation)

גרין ויז'ן מערכות בע"מ
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בעל אמצאה מכח העברה ששמה הוא:
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(באנגלית) METHOD AND DEVICE FOR REAL TIME HIGH SPEED HIGH RESOLUTION SPECTRAL IMAGING

מבקש בזאת כי ינתן לי עליה פטנט.
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*בקשת חלוקה- pplication for Division	*בקשת פטנט מוסף- Application for Patent of Addition	*דרישת דין קדימה Priority Claim		
מבקשת פטנט from Application	*לבקשה/לפטנט for Patent/Appl.	מספר/סימן Number/Mark	תאריך Date	מדינת האיגוד Convention Country
ס.____ מס'	No.____ מס'			
ated____ מיום	dated____ מיום			

*יפוי כח: ~~כללי/ מיוחד רצוף בזה~~/ עוד יוגש
.O.A.: ~~general / specific – attached/~~ to be filed later
las been filed in case ____ הוגש בענין

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FOR THE APPLICANT
Applicant File No.: 02/23415

היום 07 בחודש IV שנת 2002
This 7th of April 2002

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METHOD AND DEVICE FOR REAL TIME HIGH SPEED HIGH RESOLUTION SPECTRAL IMAGING

APPLICATION FOR PATENT

Inventor: Danny S. MOSHE

Title: METHOD AND DEVICE FOR REAL TIME HIGH SPEED HIGH RESOLUTION SPECTRAL IMAGING

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to spectral imaging and, more particularly, to a method and device for real time high speed high resolution spectral imaging. The present invention is based on using piezoelectric technology and specially designed control and analysis algorithms featuring the use of spectral image correcting adaptive look-up-tables (LUTs), for enabling nanometer accuracy positioning, along with assuring high thermal and mechanical stabilities of critical spectral imaging system components, thereby providing the real time high speed high resolution spectral imaging.

In spectral imaging, generally, a sample, preferably particulate in form, of a substance, is affected in a way, for example, excitation by incident ultraviolet electromagnetic radiation upon the sample, which causes the sample to emit electromagnetic radiation featuring an emission spectrum. The emitted electromagnetic radiation is recorded by an instrument such as a scanning interferometer that generates a set of interferogram images, which in turn are used to produce a spectral image, also referred to as a cube image, of the sample. Each cube (spectral) image is a three dimensional data set of voxels (volume of pixels) in which two dimensions are spatial coordinates or position, (x, y), in the sample and the third dimension is the wavelength, (λ), of the imaged (emitted) light of the sample, such that coordinates of each

voxel in a spectral image or cube image may be represented as (x, y, λ). Any particular wavelength, (λ), of imaged light of the sample is associated with a set of cube images or spectral fingerprints of the sample in two dimensions, for example, along the x and y directions, whereby voxels having that value of wavelength constitute the pixels of a monochromatic image of the sample at that wavelength. Each cube image, featuring a range of wavelengths of imaged light of the sample is analyzed to produce a two dimensional map of one or more physicochemical properties of the sample..

Current techniques of spectral imaging are significantly limited when employed in the wavelength range of about 100 nm to about 800 nm. In this spectral range, during the generating and collecting of spectral data using a spectral imaging system, typically, spatial errors and spectral errors are intrinsically generated and translate directly to decreasing the quality, that is, the resolution, and reproducibility of the spectral images of a given sample.

There is a need for, and it would be highly advantageous to have a method and device for real time high speed high resolution spectral imaging.

SUMMARY OF THE INVENTION

The present invention relates to a method and device for real time high speed high resolution spectral imaging. The present invention is based on using piezoelectric technology and specially designed control and analysis algorithms featuring the use of spectral image correcting adaptive look-up-tables (LUTs), for enabling nanometer accuracy positioning, along with assuring high thermal and mechanical stabilities of critical spectral imaging system components, thereby providing the real time high speed high resolution spectral imaging.

The present invention successfully overcomes several limitations, and widens the scope, of presently known techniques of spectral imaging.

Implementation of the present invention involves performing or completing selected tasks or steps manually, semi-automatically, fully automatically, and/or, a combination thereof. Moreover, according to actual instrumentation and/or equipment used for implementing a particular preferred embodiment of the disclosed method and device, several selected steps of the present invention could be performed by hardware, by software on any operating system of any firmware, or a combination thereof. In particular, as hardware, selected steps of the invention could be performed by a computerized network, a computer, a computer chip, an electronic circuit, hard-wired circuitry, or a combination thereof, involving a plurality of digital and/or analog, electrical and/or electronic, components, operations, and protocols. Additionally, or alternatively, as software, selected steps of the invention could be performed by a data processor, such as a computing platform, executing a plurality of computer program types of software instructions or protocols using any suitable computer operating system.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is herein described, by way of example only, with reference to the accompanying drawings. With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only, and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the present invention. In this regard, no attempt is made to show structural details of the present invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice. In the drawings:

FIG. 1 is a block flow diagram illustrating an exemplary preferred embodiment of the method for real time high speed high resolution spectral imaging, in accordance with the present invention;

FIG. 2 is a schematic diagram illustrating a top view of an exemplary preferred embodiment of the device for real time high speed high resolution spectral imaging, in accordance with the present invention; and

FIG. 3 is a computer generated 'simulated' image of a top view of the exemplary preferred embodiment of the device, schematically illustrated in FIG. 2, for real time high speed high resolution spectral imaging, in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention relates to a method and device for real time high speed high resolution spectral imaging. The present invention is based on using piezoelectric technology and specially designed control and analysis algorithms featuring the use of spectral image correcting adaptive look-up-tables (LUTs), for enabling nanometer accuracy positioning, along with assuring high thermal and mechanical stabilities of critical spectral imaging system components, thereby providing the real time high speed high resolution spectral imaging.

It is to be understood that the present invention is not limited in its application to the details of the order or sequence of steps of operation or implementation of the method, or, to the details of construction, arrangement, and, composition of the components of the device, set forth in the following description, drawings, or examples. The present invention is capable of other embodiments or of being practiced or carried out in various ways. Also, it is to be understood that the phraseology, terminology, and, notation, employed herein are for the purpose of description and should not be regarded as limiting.

Steps, components, operation, and implementation of a method and device for real time high speed high resolution spectral imaging, according to the present invention are better understood with reference to the following description and accompanying drawings.

FIG. 1 is a block flow diagram **10** illustrating an exemplary preferred embodiment of the method for real time high speed high resolution spectral imaging.

FIG. 2 is a schematic diagram illustrating a top view of an exemplary preferred embodiment of the device **20** for real time high speed high resolution spectral imaging.

FIG. 3 is a computer generated 'simulated' image of a top view **30** of the exemplary preferred embodiment of the device **20**, schematically illustrated in FIG. 2, for real time high speed high resolution spectral imaging.

The present invention features several aspects of novelty and inventiveness. The present invention enables one to design and construct a spectral imaging system which provides high speed high resolution spectral imaging for real time applications. The method and device of the present invention may be incorporated into a spectral imaging system for rapidly grabbing interferogram images having high resolution and reproducibility, using a combination of nanometer accuracy positioning closed-loop technology, based on using piezoelectric technology and specially designed control and analysis algorithms, for enabling nanometer accuracy positioning, along with high thermal and mechanical stabilities, of critical spectral imaging system components.

During the spectral imaging of a sample, for a given field of view, FOV, the present invention includes the implementation of several 'algorithmic' imaging signal filters prior to and following performing fast fourier transform (FFT) of the imaging signal, as shown in FIG. 1. This translates to generating high quality, high resolution, cube (spectral) images from each FOV, having high spatial and spectral resolution.

Referring to block flow diagram **10** illustrated in FIG. 1, implementation of the present invention enables achieving high performance results using continuous tasks which compensate and tune several affects during spectral imaging. Specifically, piezoelectric vs. capacitor sensor movement linear compensations, using a closed-loop DSP running an algorithm featuring the use of one or more adaptive look-up-tables (LUTs), referred to in FIG. 1 by the blocks including the text 'Multi-LUT-1 Images Correction' and 'Multi-LUT-2 Images Correction'. Fixing a spatial non-uniformity intensity effect algorithm. Calibration and/or fixing of the emission spectrum of each pixel in the cube (spectral) images, using an algorithm featuring the use of one or more adaptive look-up-tables (LUTs) and coherent light sources.

Additional aspects and advantages of the present invention are as follows:

- Compact platform.
- Low power consumption.
- High mechanical and thermal stabilities.
- High speed grabbing of cube (spectral) images.
- Rapid tunable scanning rate of less than 50 millisecond for an entire cube (spectral) image.
- Self spectral and special calibration optional capabilities.

Referring to FIGS. 2 and 3, the spectral imaging device **20** of the present invention features a solid state spectral sensor **22**. It is especially noted that the piezoelectric device (piezo device) **24** acts upon the backside of the mirror **26** having very high reflection, which is totally external to the optics, that is, totally external to the objectives **28** and the beam splitters **29** of the spectral imaging device **20**. Moreover, the piezoelectric device **24** is designed and constructed as part of the metallic structured platform which is external to the optics components **28** and **29** of the spectral imaging device **20**. This specific design and construction of the piezoelectric device **24**, as part of the overall spectral imaging device **20** illustrated in FIGS. 2 and 3, is implemented with specially designed control and analysis

algorithms (FIG. 1) for enabling nanometer accuracy positioning, along with high thermal and mechanical stabilities, of critical spectral imaging system components, thereby providing the real time high speed high resolution spectral imaging.

For producing the high speed, high-performance, high-repeatability, the optics, that is the objectives **28** and the beam splitters **29** of the spectral imaging device **20**, are positioned on an Invar metallic structured platform. Nanometer accuracy mechanical movement capabilities are provided to that part of the Invar platform where the optics **29** are assembled. Moreover, the piezoelectric device **24** is part of the Invar platform and generates the nanometer accuracy movement with very high accuracy and precision. This enables the processing of the above described specialized algorithms which provide high spatial and spectral resolution of the acquired cube (spectral) images.

While the invention has been described in conjunction with specific embodiments and examples thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims.

WHAT IS CLAIMED IS:

1. A method for real time high speed high resolution spectral imaging, as substantially described hereinabove, based on using piezoelectric technology and specially designed control and analysis algorithms for enabling nanometer accuracy positioning, along with high thermal and mechanical stabilities, of critical spectral imaging system components, thereby providing the real time high speed high resolution spectral imaging.

2. A device for real time high speed high resolution spectral imaging, as substantially described hereinabove, based on using piezoelectric technology and specially designed control and analysis algorithms for enabling nanometer accuracy positioning, along with high thermal and mechanical stabilities, of critical spectral imaging system components, thereby providing the real time high speed high resolution spectral imaging.

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Proprietary

Hipper Spectral Imaging Method/Device
HIS-20

10

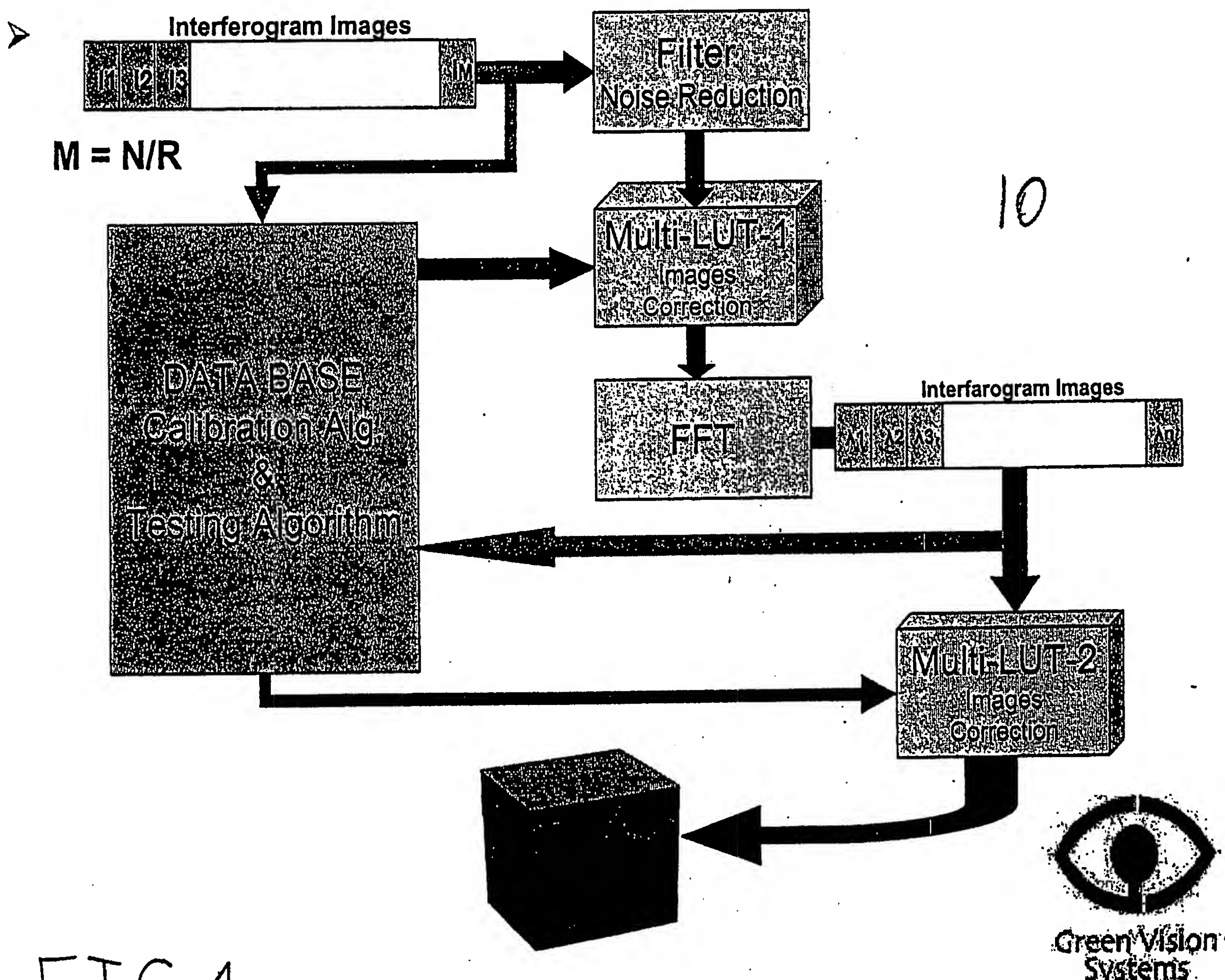

FIG. 1

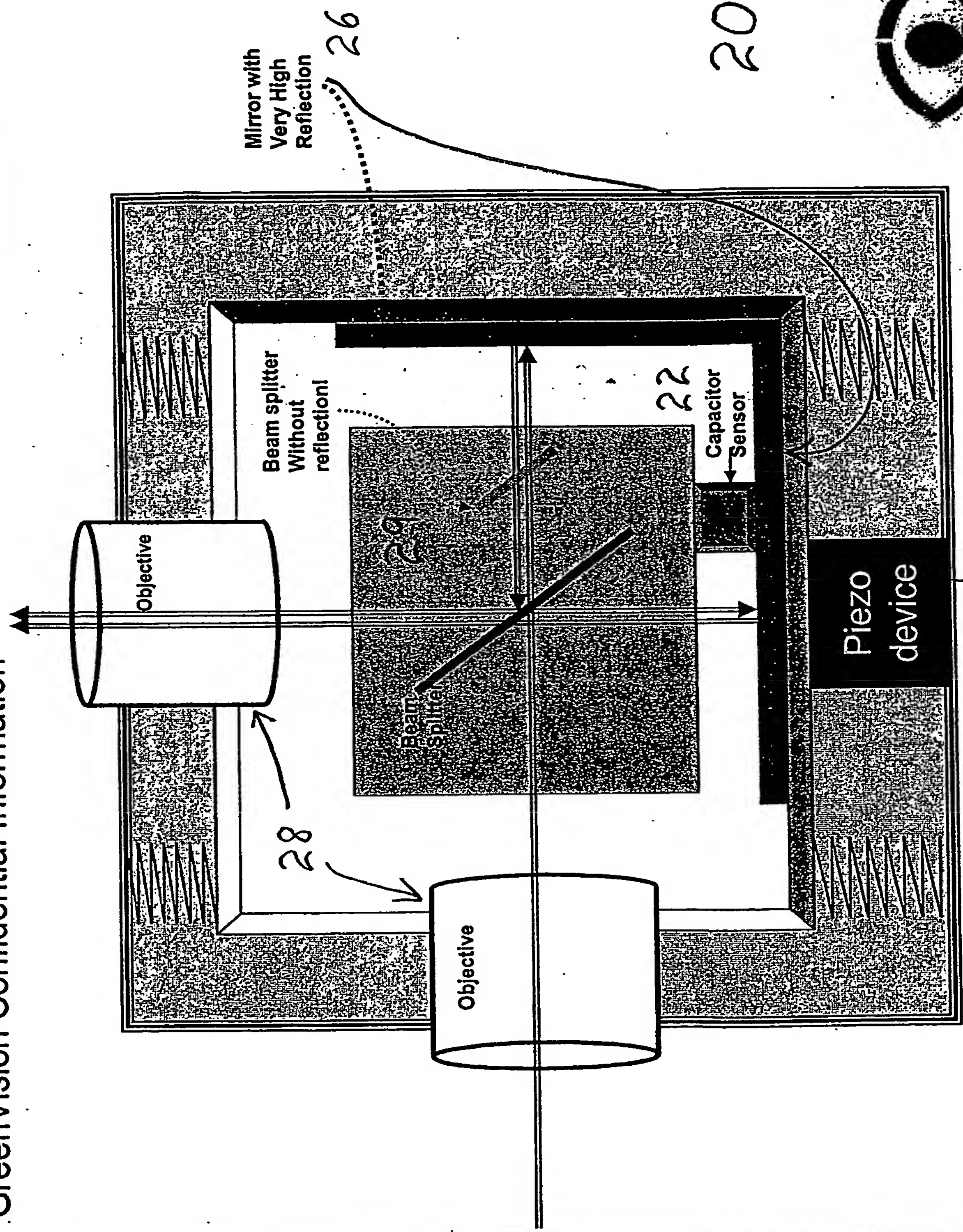

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FIG. 2

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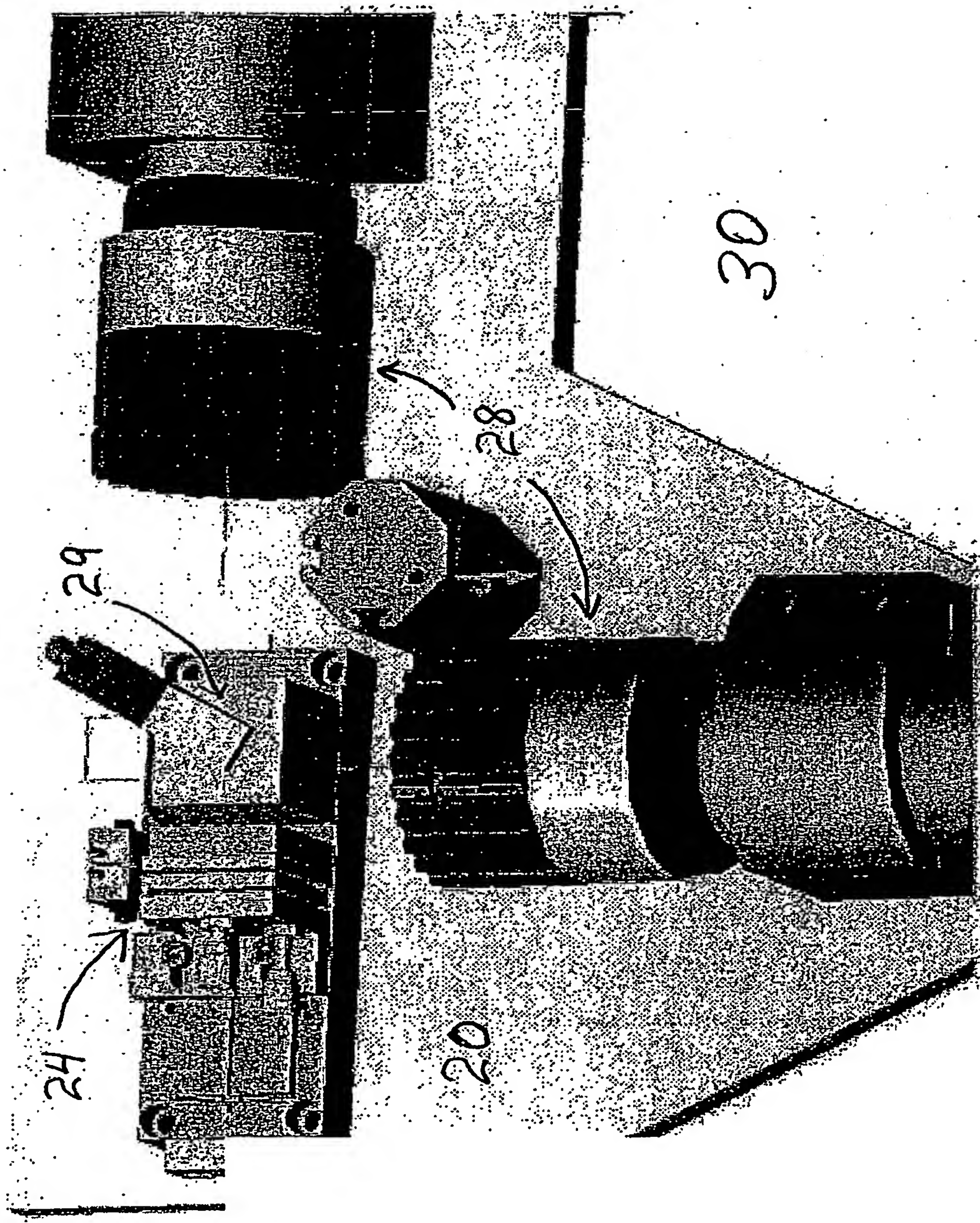

FIG. 3